Development of a hybrid PIC/DSMC Code

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Within the small satellite program of the Institute of Space Systems (IRS) of the University of Stuttgart a lunar satellite is under development. The satellite will be equipped with two electric propulsion systems. The main propulsion system will consist of four **i**nstationary **m**agneto**p**lasma**d**ynamic (IMPD) thrusters, which are also known as pulsed plasma thrusters (PPT). The duration of a single pulse is of the order of 10 µs. The current of about 30 kA allows acceleration of the propellant mass bit leading to exit velocities of about 14 km/s, i.e. a specific impulse of approximately 1400 s. [4] Due to the instationary operation and the degree of rarefaction, no continuous partition function of the propelling plasma is to be expected.

In order to model the thrust of such an IMPD thruster, a cooperation between IRS, IAG (Institute for Aerodynamics and Gas Dynamics, University of Stuttgart), HLRS (High Performance Computing Center Stuttgart) and IHM (Institute for High Power and Microwave Techniques, Research Center Karlsruhe) has been formed. Within the project "Modelling and Simulation on High Performance Computers", which is funded by the federal state Baden-Württemberg, a hybrid PIC/DSMC (Particle in Cell/Direct Simulation Monte Carlo) scheme will be developed within two years.

In order to model the physics, the PIC scheme developed by IHM [2, 3] will be extended by models for intermolecular collisions used in the DSMC code LasVegas [1]. Within the PIC code the Vlasov-Maxwell equations are solved in order to describe the interaction between charged particles and electromagnetic fields. The DSMC method models the exchange of momentum and energy as well as chemical reactions neglecting Lorentz forces. It is expected that the coupling of both methods will allow for the modeling of losses within IMPD thrusters due to incomplete ionization of the propellant. The necessity of a three dimensional description requires optimization and parallelization of the code in order to effectively use high performance computers.

In the paper the current state of development after approximately one year of development will be described and preliminary results will be discussed.

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[3] Munz, C.D., Schneider, R., Voß, U.: A Finite-Volume Particle-in-Cell Method for the Numerical Simulation of Devices in Pulsed Power Technology, Surv. Math. Ind., 1999.

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